Aggregate Tactics, Techniques, and Procedures for Naval Warfare Systems Certification Policy (NWSCP) – Criteria 2

20 May, 2014

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Criteria 2: Overview

- **NAVSEAINST 9410.2A Naval Warfare System Certification Policy – Criteria 2: Operator Workload**
  - **Input – WSEs identify all TTPs, workarounds, limitations and restrictions (to include TRs, CPCRs) for their element and provide to NAVSEA 05**
  - **Methodology –**
    - **Current – Manual methodology evaluates the aggregate impact of TTPs, workarounds, limitations and restrictions on operators and mission functions**
    - **Future – Partially automated methodology employing appropriate modeling and simulation (M&S) approach that could augment/supplement analysis previously documented by manual method**
  - **Output – Brief (including graphs) that summarizes assessment findings in terms of risk of aggregate operator workload for certification panel at ship at Warfare System Installation Assessment (WSIA) and Warfare System Certification Decision (WSCD) events for installation and deployment decisions**

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Criteria 2: Historical Development of Assessment

- **Naval Warfare Systems Certification Task Force Final Report (April 2011)**
  - **Combat Systems Certification Pillar Lead: Mr. Bill Bray (SES)**
  - **Platform Certification Pillar Lead: Ms. Trish Hamburger (SES)**
- **Operator Workload History**
  - **2005 - REAGAN (CVN 76) Operator Workload Criteria Under Development – SSDS**
  - **2006 - NIMITZ (CVN 68) Operator Workload Criteria Under Re-Development – SSDS**
  - **2012 - Operator Workload Criteria Manual Methodology Development – Aegis B/L 9**
  - **2013 - Operator Workload Criteria Manual Methodology Refinement and Model Development – SSDS**

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Criteria 2: Historical Development of Assessment

- **2005 - REAGAN (CVN 76) Operator Workload Criteria Under Development - SSDS**
  - Completed as proof of concept to determine a possible non-intrusive methodology capitalizing on in-place test underway to measure subjective ratings of cognitive operator workload
  - Results included Modified Cooper Harper Workload ratings self-reported by operators and task performance information by test team observing operators, included as part of WSERB findings
  - Methodology Lesson Learned- SMEs and operators did not find the Modified Cooper Harper (MCH) Ratings intuitive – ratings generally low across operators (even when task performance was poor) as the "sailor just makes it work" not reporting anything but low workload.
- **2012 - Operator Workload Criteria Manual Methodology Development – Aegis B/L 9**
  - Leverage the 2006 TFA method for development of manual methodology to evaluate the aggregate impact of TTPs, workarounds, limitations and restrictions on operators and mission functions
  - Select an appropriate modeling and simulation approach that allows the transition from manual method (apply M&S in follow on years)
  - Methodology Lesson Learned- Using a subset of trouble reports and operators developed metrics and operator activities and responsibilities to subjectively describe aggregate workload for operator and mission area
- **2006 - NIMITZ (CVN 68) Operator Workload Criteria Under Re-Development - SSDS**
  - Instituted the use of task function analysis frameworks representing the system and human activities for mission areas (developed by SME knowledge elicitation) to characterize aggregate impact, risk and areas for improvement.
  - Results produced more objective characterization given the systemic use of the TFAs and provided a multi-level categorical scale of magnitude, frequency of occurrence and task impact
  - Methodology Lesson Learned –Method unable to produce a "magic number" to be used to assess how much aggregate workload is too much instead workload was described in a systematized way based on SME judgments about mission areas and operator performance
- **2013 - Operator Workload Criteria Manual Methodology Refinement and Model Development –SSDS**
  - Execute manual methodology (including use of subjective metric rating) to analyze aggregate operator impact and mission impact for Trial Alpha (LPD 19) and Trial Bravo (LPD-22) without actual participation in certification panel, including development of risk scale
  - Generate foundational human performance task network model and tactical scenario to ensure that manual methodology can "feed" future semi-automated approach
  - Methodology Lesson Learned- Manual method can be applied effectively and will feed model but programmatic challenges in socializing Criteria 2 process/outputs and in obtaining items (WSE TRs and other OQE) for analysis

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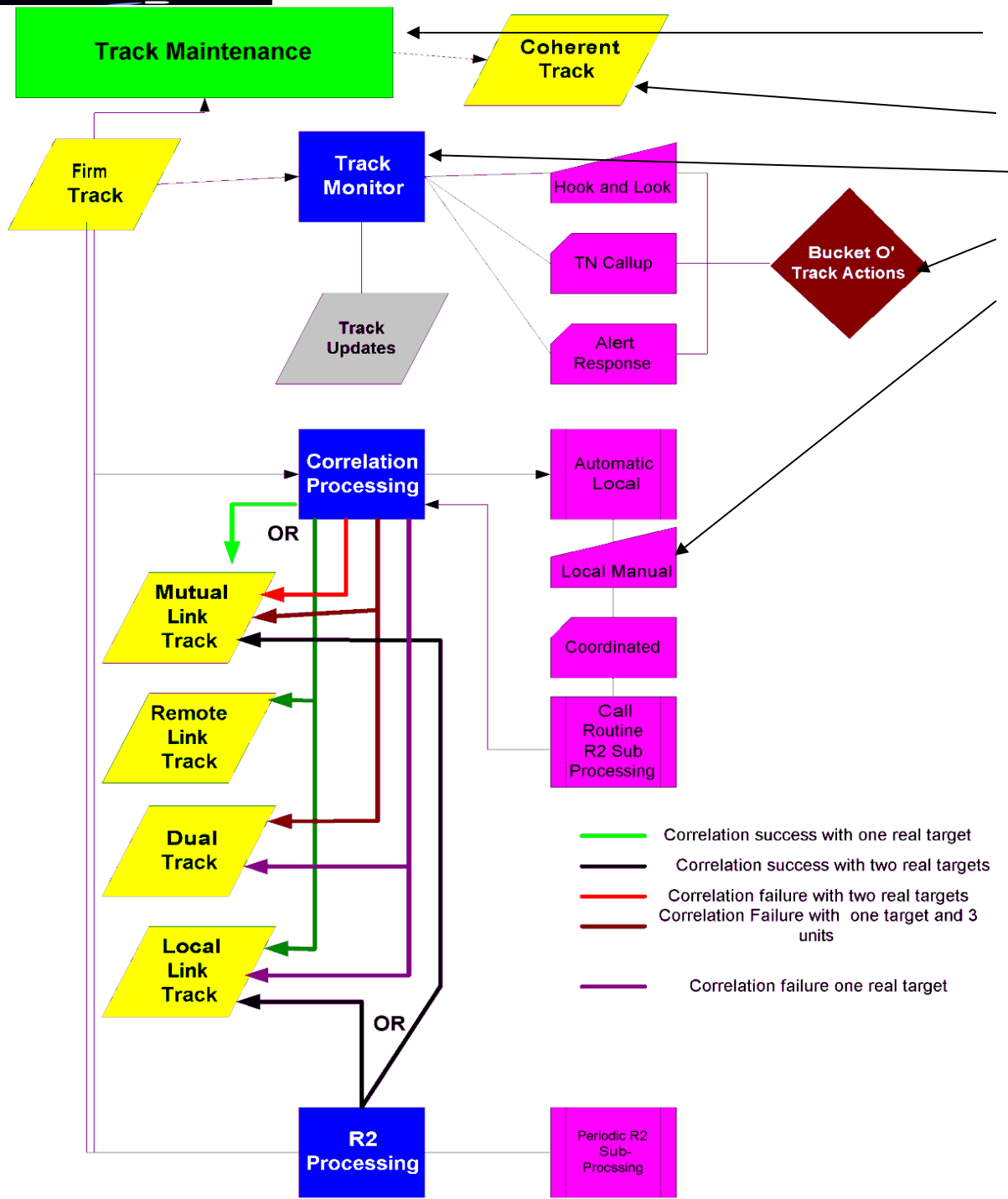

Sample TFA from 2006 SSDS Study for Track Maintenance function

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Criteria 2 Assessment Methodology

General Information
- Platform TTP
- TIC Tech Aid
- Platform C&L
- Interop C&L
- Fleet Advisories
- CSTOMS

CS Certification Information
- MR-3: System meets usability requirements under
- MR-4: Individual and cumulative effect of all uncorrected

WS Element Information
- R1 through R3 TRs (some with workarounds, TTP, etc.)
- Element or Combat System Usability Assessments
- Reference Documents (QRGs, CPDDs, Specs)

1. Plan
2. Allocate
3. Categorize
4. Evaluate
5. Aggregate
6. Assess
7. Report

Pre-Filtering Candidate Items — N: Test, Training, Sim, Readiness, Enhancements, WSEs with no Operators or SW, etc.

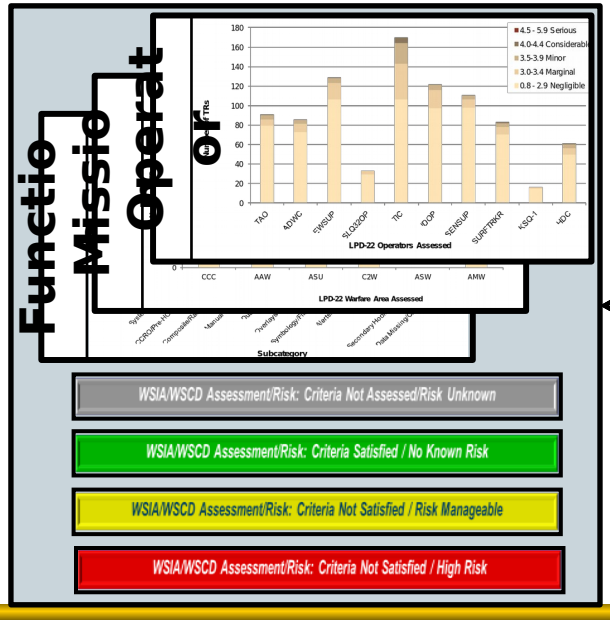
Operator Impact — N: N/A to Criteria 2

Operator
- TAO
- ADWC
- EW Sup
- SLQ-32 Op
- TIC
- ID Op
- Sensor

Operator Activities
- Plan & Setup
- Display Mgmt
- Coordinate
- Task Execution
- Information Review

Operator Responsibilities
- Plan (1)
- Track (3)
- System (3)
- Engage (3)

Mission
- AAW (Anti Air Warfare)
- CCC (Command, Control, Communications)
- ASU (Anti Surface Warfare)
- C2W (Command & Control Warfare)
- ASW (Anti Submarine Warfare)
- AMW (Anti Mine Warfare)



Per-item Metrics | *Relative Weighting* | *Individual Item Scores*

- Magnitude (1 2 3 4 5) x 0.3
- Frequency (1 2 3 4 5 6) x 0.3
- Time Off Task (1 2 3 4 5 6 7 8 9) x 0.2
- Recovery (0 1 2 3 4) x 0.1
- Missing/Incomplete Data (0 1 2 3 4) x 0.1

TR Contribution to Aggregate Workload
- 4.5 to 5.9: Serious
- 4.0 to 4.5: Considerable
- 3.5 to 3.9: Minor
- 3.0 to 3.4: Marginal
- 0.8 to 2.9: Negligible

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Step Four: Impact Metric

Impact - does the TR being evaluated directly impact the specified operator's task performance?

0. No - No direct impact to the operator that would increase workload; does not impair the ability to perform mission functions.

1. Yes -There is an impact, direct or indirect, to the operator's ability to perform primary mission functions and/or adds to the overall workload.

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Step Four: Magnitude Level Metric

Magnitude Level – degree of adverse impact on operator task performance.

1. **Minimal** – little noticeable impact, ***Negligible additional Effort and Negligible Risk*** to task completion.

2. **Minor** – noticeable impact, ***Low additional Effort and Low Risk*** to task completion.

3. **Moderate** – adverse impact, ***Medium additional Effort and Medium Risk*** to task completion.

4. **High** – adverse impact, ***High additional effort and High Risk*** to task completion.

5. **Very High** – adverse impact, ***Very High additional effort and Very High Risk*** to task completion, impacts secondary tasks.

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Step Four: Operational Frequency Metric

Operational Frequency – number of times a TR can occur given actions performed by an operator during a given period of time .

1. **< 1 time** - Does not occur once per watch, may occur 1 or more times during an operational period, such as an underway (greater than 0 but less than 1 time per watch)

2. **1-2 times** - Rarely during a 5 hour watch (1-2 times)

3. **3-5 times** - Occasionally during a 5 hour watch (3-5 times)

4. **6-10 times** - Sometimes during a 5 hour watch (6-10 times)_

5. **11-20 times** - Frequently during a 5 hour watch (11-20 times)_

6. **>20 times** - Usually during a 5 hour watch (20 or more times)

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Step Four: Time Off Task Metric

Time Off Task - duration of time it takes the operator to deal with the given TR.

1. **< 1 second**
2. **1 to < 5 seconds**
3. **5 to < 10 seconds**
4. **10 to < 20 seconds**
5. **20 to < 60 seconds**
6. **1 to < 5 minutes**
7. **5 to < 10 minutes**
8. **10 to < 20 minutes**
9. **> 20 minutes**

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Step Four: Recovery Metric

Recovery – level of disruption caused by action required for operator to recover from the TR occurrence.

0. **N/A** - No additional action possible or effort required, issue is an ***non disruptive*** inherent design limitation.

1. **Negligible** - The issue remains until the operator takes an action that is ***not disruptive*** to the current task.

2. **Minor** - The issue remains until the operator takes an action that ***is disruptive to the current task*** but is ***not disruptive to the mission***.

3. **Assisted** - The issue remains until the operator asks another operator to provide the correct information and/or correct the issue, but the correction ***is not disruptive to the mission***.

4. **Major** - The issue remains until the operator takes an action that ***is disruptive to the mission*** (system/console reset).

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Step Four: Missing or Incorrect Data Metric

Missing or Incorrect Data - whether or not the result of the TR leads to presenting missing, incomplete, or incorrect data to the operator.

0. **N/A** – Described issue is not applicable (N/A): Nature of TR does not present missing or incorrect data to the operator.

1. **Incorrect Format or Order** - Information is presented in the wrong units or format, or presentation order is incorrect or inconsistent.

2. **Mismatched** - Information is presented in multiple locations. One location(s) may have the correct information but another location(s) has incorrect information.

3. **Missing** (or Incomplete) - Information is not present in at least one location where it should be provided, or the information is obviously incomplete (not likely to be taken as the full or current information).

4. **Wrong** - Information is incorrect or inaccurate in the standard location(s) that would be referenced by the operator.

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Step Five: Aggregate

Step 5 is the roll-up of the individual TR scores to establish an aggregate workload score. The aggregate date is analyzed from several perspectives, including by operator, by activity and responsibility category, by metric category, and by mission/warfare area.

A weighting scheme is applied to properly account for the relative significance of a metric category compared to the others

- **Can be adjusted to suit the analysis**
- **What works for one baseline may not be a good fit for another**

Metric Category	Rating Scale	Relative Weight	Minimum Weighted Score	Maximum Weighted Score
Impact	Yes or No	N/A	N/A	N/A
Magnitude	1 - 5	0.30	0.30	1.50
Operational Frequency	1 - 6	0.30	0.30	1.80
Time-Off-Task	1 - 9	0.20	0.20	1.80
Recovery	0 - 4	0.10	0.00	0.40
Missing or Incorrect Data	0 - 4	0.10	0.00	0.40
Cumulative Weighted Score			**0.80**	**5.90**

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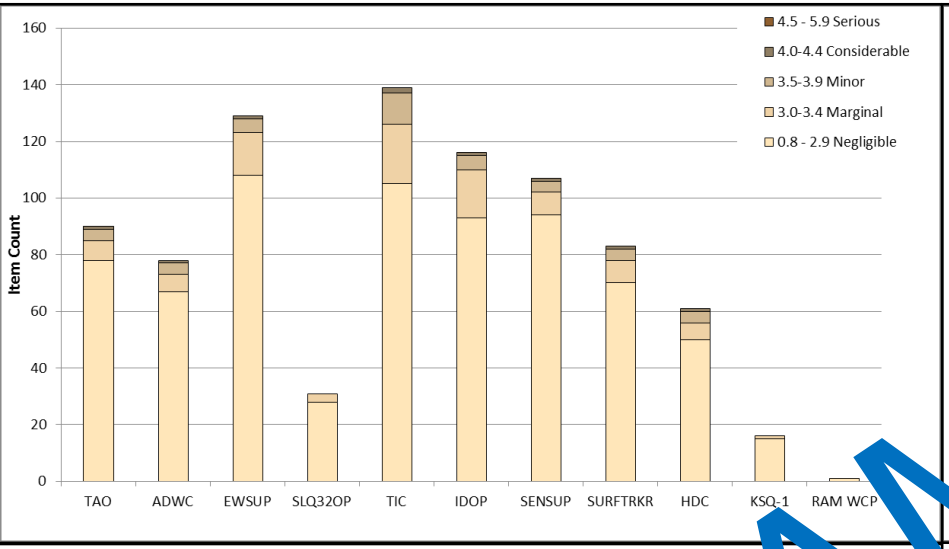
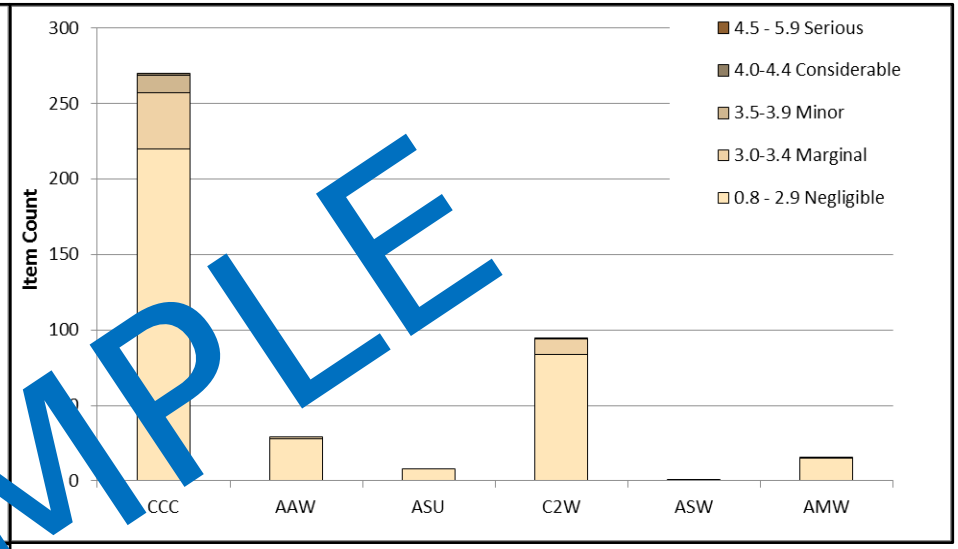
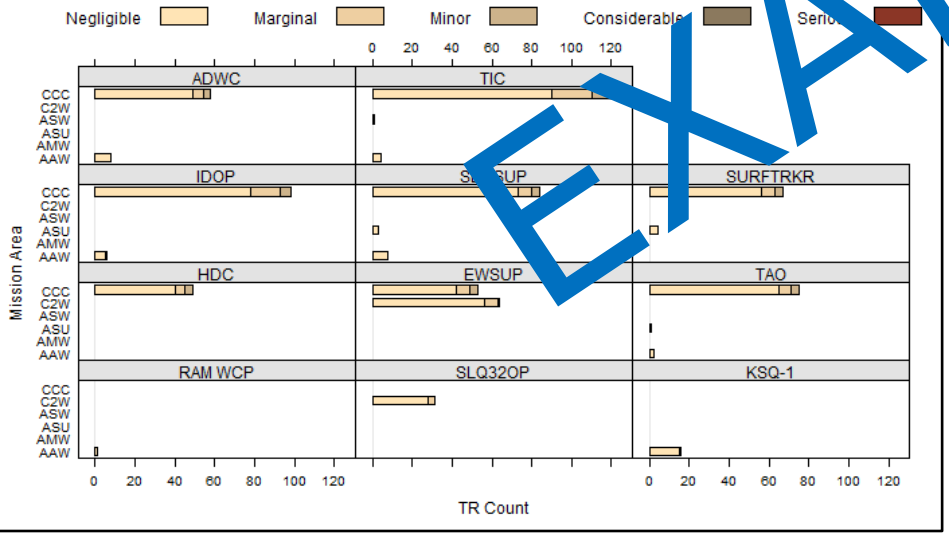
Step Six: Assess: Assessment Outputs for Fictional Ship by Operator and Mission Area







EXAMPLE

- Aggregate operator workload was deemed manageable from the 419 Items determined to have operator impact.
- Command, Control, and Communications (CCC) (containing primarily track management related Items) had the largest number of Items contributing to operator workload as well as the highest number of high scoring Items (12 Items with minor and 1 Item with considerable contribution).
- Individually, the TIC operator had the largest number of high scoring Items, 7 Items with a minor and 1 Item with a considerable contribution to aggregate workload).

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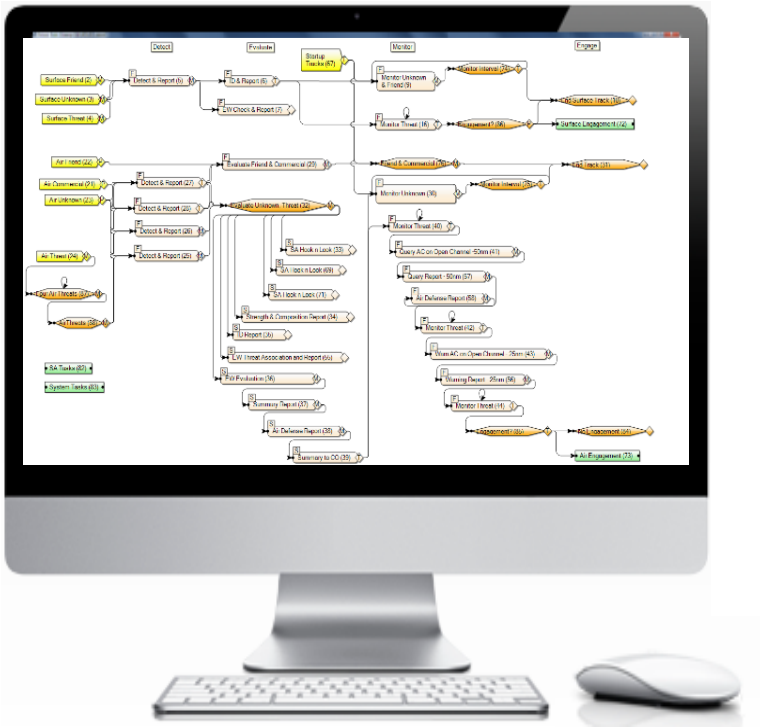
M&S Overview

Run Simulation



Define Input

- Scenario
  - Weapon system
  - Operators
  - Task durations
  - Probability distributions
  - Watch Duration
- Simulation Conditions
  - Number of Iterations (Runs)
  - Parameter Variation for TRs, Tasks, and Operators
- Track Complexity
  - Track Types
  - Track Density
  - Track Duration
- Trouble Report Metrics
  - Operational Frequency
  - Time off task
  - Recovery method

Review Output

- Operator Results
  - Mean, max, min time off task
- Mission Area Results
  - Mean, max, min time off task
- Number of TRs impacting operator and warfare area
- Auto-generated charts showing aggregated results for operators and mission areas
- Comparisons over time of cert event results to past simulation runs using similar TR data

Represents TR impact on operator detect to engage task performance.

Simulates aggregate workload during a tactical scenario.

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Criteria 2 Assessment Methodology Complemented by M&S

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General Information
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- Fleet Advisories
- CSTOMS

CS Certification Information
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- MR-4: Individual and cumulative effect of all uncorrected

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Operator Impact — N: N/A to Criteria 2; Y

Operator
- TAO
- ADWC
- EW Sup
- SLQ-32 Op
- TIC
- ID Op
- Senso

Operator Activities
Plan & Setup Display Mgmt
Coordinate Task Execution
Information Review
Track (3) Engage

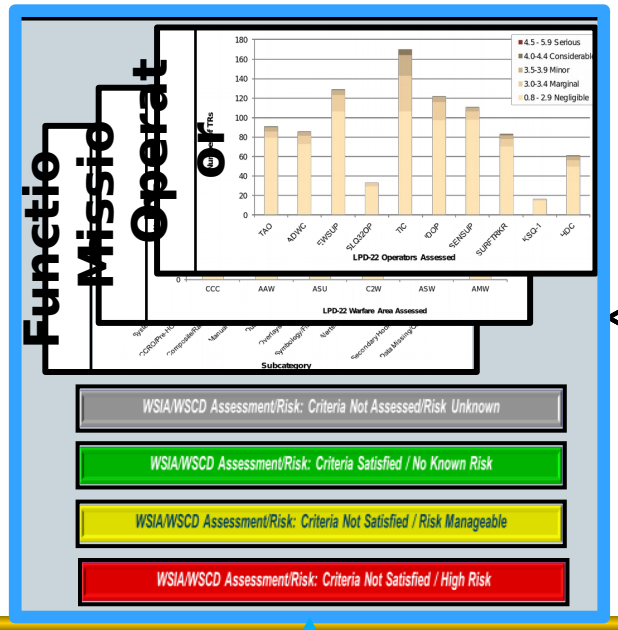
Mission
AAW (Anti Air Warfare)
CCC (Command, Control, Communications)
ASU (Anti Surface Warfare)
C2W (Command & Control Warfare)
ASW (Anti Submarine Warfare)
AMW (Anti Mine Warfare)

Per-item Metrics | *Relative Weighting*

Magnitude	1 2 3 4 5	x 0.3
Frequency	1 2 3 4 5 6	x 0.3
Time Off Task	1 2 3 4 5 6 7 8 9	x 0.2
Recovery	0 1 2 3 4	x 0.1
Missing/Incomplete Data	0 1 2 3 4	x 0.1

Individual Item Scores

Sim input



Sim output

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Modeling and Simulation Benefits and Challenges in Representing Manageable and Un-Manageable Aggregate Workload

Modeling and Simulation has the potential to supplement the manual methodology by:

- **Enhance Manageability of Assessment**
  - Provides a means to analyze the impact of multiple TRs occurring dynamically in a realistic CIC tactical scenario
  - Simulation will take into account how multiple TRs may occur concurrently for different operators and tasks throughout a scenario
- **Improve Efficiency**
  - Provides a rapid method to summarize the impact of TRs on operator manageability of aggregate workload
  - Simulation will generate results and can execute multiple runs for analysis quickly
  - Simulation represents “downstream” adverse impacts on track processing
- **Better Experimentation**
  - Provides an easier method to vary and investigate the factors that could influence aggregate workload such as # of TRs, weighted scores, and TR types
  - Provides comparison of operator task performance with and without TRs
  - Simulation input file can be manipulated to allow the Critical Analyst to easily modify tactical scenario

Modeling and Simulation implementation challenges may include:

- **Model Representation Verification**
  - Ensure that scenario, operator task sequences, and task parameters (such as frequency, distribution etc.) is representative of real-world conditions likely to be encountered by Fleet
  - Obtain approval and concurrence of model representation (validation and verification as well as buy-in by stakeholders)
  - Verify adequate task decomposition and representation to represent all TRs/items contributing to aggregate operator workload
- **Model Construction Considerations**
  - Model must be extensible to mission areas, operator tasks, and tactical scenarios encountered by all ship classes that will have certification assessments
  - Model may require additional modifications to simulate the tactical conditions experienced by the Fleet

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Manual Method Challenges

- **Scoring is done at the individual TR level, ascertaining the meaning of the aggregated results based on the weighted score is difficult**
- **Due to the sheer number of TRs it is resource intensive to score and manage disparate data sets**
- **Manual method makes it difficult to track which TRs or sets of TRs might take place simultaneously or along with other operator tasks/responsibilities forming a particularly demanding portion of the detect to engage sequence**
- **Doesn't consider non-TR related workload**

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M&S Challenges

- Ensuring that the task frequencies, distributions, track density etc. represent the operational environment experienced by the Fleet
- Non-existent set of empirical data from which to compare SME estimates used as the foundation in the model with more representative real-word data
- Using time off task as a main result of the model may need to expanded to include other human performance impacts that are more descriptive
- Chosen to make model unclassified even though the level of fidelity may have been improved by classified details
- Model will not replace the need for the manual methodology where metrics are scored are based

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Back ups

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Collaborative Team Members

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We are happy to discuss any ideas/questions you might have on this project. We appreciate your inputs.

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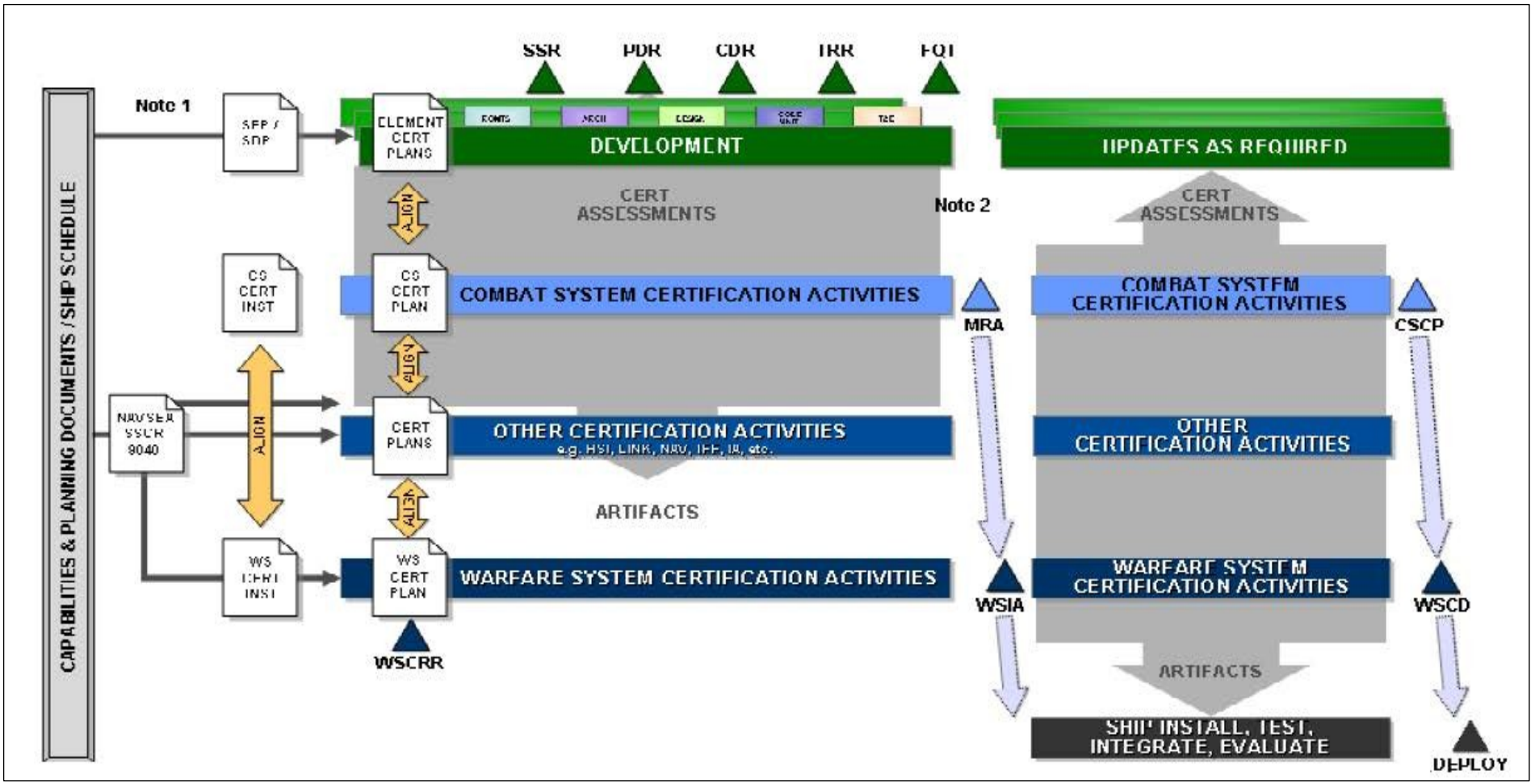
Step One: Certification Timelines



Alignment of Combat System Certification Process with Warfare Systems Certification Process

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Presentation of Assessment Findings for Cert Officials and PEO IWS

WSIA/WSCD Assessment/Risk: Criteria Not Assessed/Risk Unknown

- Assessment not conducted for Criteria 2

WSIA/WSCD Assessment/Risk: Criteria Not Satisfied / High Risk

- For assessments with <75% of elements assessed
- For assessments with >75% of elements assessed and one or more essential operators have unmanageable workload
- Essential Operator is defined as any operator who must be able to perform their tasks at an manageable workload in order for a primary mission areas to be fulfilled in a satisfactory manner

WSIA/WSCD Assessment/Risk: Criteria Not Satisfied / Risk Manageable

- For assessments with between 75% and 90% of elements assessed and no essential operators have unmanageable workload

WSIA/WSCD Assessment/Risk: Criteria Satisfied / No Known Risk

- For assessments with >90% of elements assessed and no essential operators have unmanageable workload

NAVSEAINST 9410.2A Naval Warfare System Certification Policy- Only Analytical Process of 20 Criteria

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